***How does the levels of selection question relate to the 'major evolutionary transitions'?*** Such transitions, as defined by Eörs Szathmáry and John Maynard Smith, occur when free-living biological units, capable of surviving and reproducing alone, coalesce into a single larger unit, giving rise to a new, higher-level individual — for example, in the evolution of multi-celled organisms from single-celled ancestors. In transitions of this sort, there is the potential for selection to act on both the smaller and the larger units — the individuals and the groups. For the groups to evolve into 'real' individuals, i.e. integrated cohesive units, group-level selection must trump individual-level selection. So multiple levels of selection are intimately involved with evolutionary transitions.

***What about species selection?*** This was an idea defended by Stephen J. Gould and other macroevolutionists, which says that selection may operate on whole species over geological time, favouring those species best able to survive or reproduce (i.e. speciate). This could explain why certain types of species, e.g. ecological specialists, become more common than others, e.g. generalists, in a given clade, and thus indirectly help explain long-term evolutionary trends. Species selection is certainly a logical possibility, but it is difficult to assess how important an evolutionary process it has been.

***Where can I find out more?***

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# Absence of racial, but not gender, stereotyping in Williams syndrome children

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Stereotypes — often implicit attributions to an individual based on group membership categories such as race, religion, age, gender, or nationality — are ubiquitous in human interactions. Even three-year old children clearly prefer their own ethnic group and discriminate against individuals of different ethnicities [1]. While stereotypes may enable rapid behavioural decisions with incomplete information, such biases can lead to conflicts and discrimination, especially because stereotypes can be implicit and automatic [2], making an understanding of the origin of stereotypes an important scientific and socio-political topic. An important process invoked by out-groups is social fear [3]. A unique opportunity to study the contribution of this mechanism to stereotypes is afforded by individuals with the microdeletion disorder Williams syndrome (WS), in which social fear is absent, leading to an unusually friendly, high approachability behaviour, including towards strangers [4]. Here we show that children with WS lack racial stereotyping, though they retain gender stereotyping, compared to matched typically developing children. Our data indicate that mechanisms for the emergence of gender versus racial bias are neurogenetically dissociable. Specifically, because WS is associated with reduced social fear, our data support a role of social fear processing in the emergence of racial, but not gender, stereotyping.

A variety of cognitive, social/behavioural and emotive processes could in principle contribute to stereotyping. The study of populations with clear impairments in these functions can therefore provide information about the underlying neurobiology. In the first application of this approach, children with autism, which have profound impairments in theory of mind and social interactions, were found to make stereotypical judgments based on race and gender, just like typical children [5]. Here, we used the same task [5] (see Supplemental information available online with this issue) to investigate racial and gender stereotyping (Figure 1A) in a group of twenty children with WS (10 female and 10 male) aged 7 to 16 years (M = 12.9; SD = 2.8), and twenty control children aged 5 to 15 years (M = 7.0; SD = 1.8), individually matched to WS participants on gender (10 female and 10 male) and mental age ($F$ (1, 38) = 2.97, $p > 0.09$). As a group, the participants with WS had IQs within the usual range for this condition, but contained a proportion of high-performing, normal IQ subjects.

Confirming previous work, the control children showed strong pro-Caucasian bias ($X^2$ (1,19) = 60.33, $p < 0.001$). In contrast, no evidence of race bias was found with the WS children (Figure 1B), whose scores were not statistically different from 50% ($X^2$ (1,19) = 28.0, $p > 0.05$), indicating that they attributed positive and negative features equally to Caucasian (in-group) and non-Caucasian (out-group) characters. Conversely, sex-role bias was pronounced and identical in the two groups ($p > 0.99$), indicating that absent racial stereotypes were not due to an overall feature attribution impairment. Chronological age differences between the WS and the control groups, or intellectual difficulties in WS children were unrelated to these findings (see Supplemental information).

To our knowledge, this is the first indication of the absence of racial stereotyping in a human group. While it is possible in principle that children with WS were differentially exposed to other ethnicities, this is unlikely as they were recruited from similar social backgrounds, and stereotypes emerge in normally developing children without such exposure [1]. Our results therefore indicate that it was WS that had dissociable effects on gender and race bias, suggesting differential neurobehavioral mechanisms for the development and/or maintenance of these stereotype categories.

As stated, reduced social fear is a hallmark characteristic of WS, linked to overfriendliness and social disinhibition, even with individuals

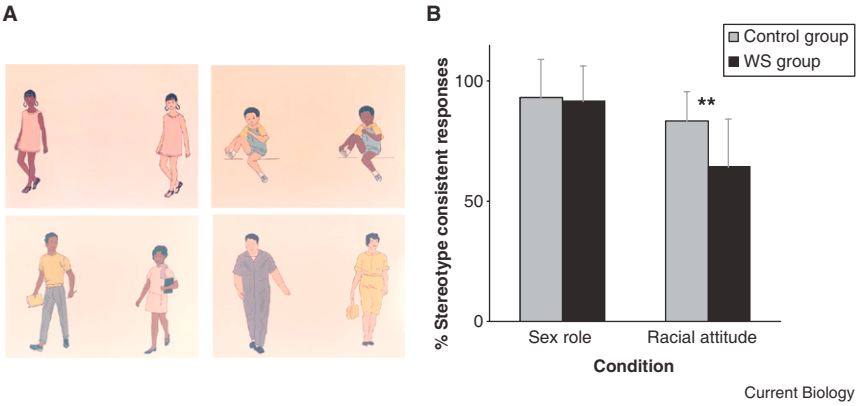


Figure 1. Lack of racial stereotyping by WS children.

(A) Examples of racial-attitude (top) and sex-role (bottom) items. Racial attitude items: the two figures in each picture were identical except for the skin-colour difference — pinkish-tan *versus* medium brown. Figures of both sexes were employed, and a variety of ages were represented. The figures were drawn in a variety of sitting, standing, and walking positions, with the pictures being otherwise generally ambiguous as to any activities in which the persons represented might be engaged. Each picture was accompanied by a story containing one of six positive evaluative adjectives (such as kind, pretty, smart) or one of six negative evaluative adjectives (such as, bad, ugly, stupid), with the child being asked which of the two persons was the one described in the story. Sex role items: each of the sex role items displayed a male and female figure of the same general age, and of the same race (half of the pictures represented Caucasians; half, non-Caucasians). Sex role items assessed the child's knowledge of typical sex-stereotyped behaviours, and provided a control measure of general conceptual development. (B) Contrast of percentage-transformed responses in the in-group (sex-role) and the out-group (racial-attitude) conditions, 50% indicating no bias. Children with WS and control children showed a similar stereotype-consistent bias on the sex-role condition. Yet, on the racial-attitude condition, children with WS responses were significantly less stereotype-consistent than that of controls (Group x Condition interaction: $F$ (1,38) = 7.93; $p$ = 0.007), and showed no evidence for bias ($X^2$ (1,19) = 28.0, $p > 0.05$).

that objectively are considered as not approachable [4]. Our results, while they do not completely exclude alternative explanations, therefore suggest that social fear contributes to the development of racial stereotype: gregarious social behaviour in WS could lead to reduced race bias, but absent racial stereotypes could themselves contribute to hypersociability, meaning that the directionality of this hypothesized interaction cannot be inferred from our data. Conversely, preserved sex-role stereotyping in WS indicates that social fear does not play a prominent role in this exemplar of stereotype. We therefore obtained a first indication that mechanisms underlying different forms of stereotypes are not uniform. Rather, our data suggest that other cognitive processes such as social imitative learning and overgeneralization may play a role in sex-role bias.

At the neural level, reduced social fear and hypersociability in a different group of high-functioning individuals with WS has been traced to diminished amygdala reactivity to social threats in the context of abnormal amygdala regulation with prefrontal cortex [6], and to decreased interactions between the fusiform face area (FFA) and amygdala [7], findings that have subsequently been confirmed in individuals with WS and intellectual impairment. Interestingly, these regions are thought to be the neural substrates underlying race information processing in typically developing individuals. Specifically, previous studies found heightened FFA activation in Caucasian and non-Caucasian individuals while viewing own-race faces [8]. In the amygdala, studies have reported increased activity for non-Caucasian relative to Caucasian faces in both Caucasian and non-Caucasian individuals [9]. Finally, prefrontal regulation of amygdala is invoked when subjects move beyond stereotypical to individual judgements about out-group members [10].

These findings are consistent with the speculation that decreased amygdala and FFA activity and interactions reduce implicit race bias in WS through diminished signalling of the social threat associated with a race out-group. This idea could be tested directly by a combined neurogenetic-imaging approach, which could also use other out-group ethnicities, to which participants have not been exposed, to control for the effect of novelty, which can also affect amygdala activation. More generally, our data provide evidence for neurogenetically dissociable pathways of stereotyping, the further study of which may suggest ways of reducing biased behaviour towards vulnerable or marginalized groups.

## Supplemental Information

Supplemental information is available at http://www.cell.com/current-biology/supplemental/S0960-9822(10)00144-2

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